GUNSHOT INJURIES OF THE KNEE-JOINT IN A BASE HOSPITAL

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At the base hospitals it was possible to keep for treatment, for a period varying from one to three months, patients who by necessity were evacuated from the evacuation hospitals in a few hours after their operation. The results of certain operative procedures, complications arising in special types of injuries as well as the probable functional results in these injuries, could therefore be observed at the base hospital. In this paper, gunshot wounds of the knee-joint will be so considered.

The primary operations in injured knee-joints were usually done at the evacuation hospitals where the policy of operative interference was fairly uniform. Through and through machine-gun bullet wounds of the knee without marked destruction of the articular surfaces were not usually operated upon. Hæmarthrosis or marked effusion into the joint in such cases was usually aspirated. Practically all penetrating and perforating wounds from high explosives were operated as soon as possible, the wounds of the soft parts débrided, foreign bodies and loose bone fragments removed from the joint, and the capsule of the joint closed if possible. If infection had already manifested itself or was probable, the joint was left open. Long oblique fractures into the joint were usually subjected to a débridement of the wound over the fracture and the joint was not opened. It was, as a rule, not possible to hold these cases at the front more than forty-eight hours, and they were evacuated with the joint immobilized in a Thomas splint to the base hospital, where they were held until complications were cared for and a definite convalescence established.

A group of such injuries in Base Hospital No. 13 will be considered from the standpoint of the original lesion, the type of operation performed at the front, the subsequent complications and their treatment as related to the function of the joint. Fifty-five cases had sufficiently good records for study. Forty-nine were operated at the front on an average of 1.8 days after their injury and of these forty-two were operated within twenty-four hours after injury. Of the whole group thirty-one or fifty-six per cent. remained uninfected after operation, and twenty-four or forty-four per cent. became infected. The influence of early operation in prevention of infection is instanced in the seven joints operated later than twenty-four hours after injury. Five became infected, the average time of operation being eight days after injury.

Infection is the most important factor in decreasing the ultimate usefulness of the joint. The type of injury to the joint, the post-oper-

ative treatment of the joint, and concurrent injuries to neighboring structures also play a rôle, but a less important one. The striking influence of infection on the function of injured joints is instanced by the results of examination of these cases on an average of three months after their injury. Of the thirty-one *non*-infected joints, twelve had normal motion and eighty-one per cent. had a range of more than fifteen degrees of active motion. Of the infected joints, five were amputated, and of the eighteen remaining only two had normal motion, and seventy-three per cent. had less than fifteen degrees of active motion.

Having seen the bad results of infection of the joint on its subsequent function, let us consider the relation of operative procedures employed at the front to subsequent infection of the joint.

In twenty-seven cases having a closure of the joint after operation at the front, sixty per cent. remained clean. Closure of the capsule alone leaving the soft parts open was the treatment in fourteen cases, and closure of the capsule and soft parts including skin was done in thirteen cases. Of the first group seventy-one per cent. remained clean, whereas only fifty-four per cent. remained uninfected where both the capsule and soft parts were closed. This points strongly to the advisability of capsule closure only, unless the patient can be held for observation.

In seventeen cases it was thought inadvisable or impossible to close either the capsule or soft parts after operation at the front, and the joint was left open. It is rather surprising that nearly fifty per cent. of these joints remained clean. This may be exceptional and surely presupposes a thorough débridement of the wound and revision of the joint.

Six cases were not operated at the front, five of which were perforating machine-gun bullet wounds of the knee-joint with no foreign body in the joint and with very little derangement of the joint. All of these remained clean and had splendid functional results, three having normal motion and two forty degrees of active motion after two and one-half months. One high explosive injury of the knee-joint was not operated at the front because it was thought the wound was simply one of the soft parts. This was in error and the joint became infected.

In the consideration of these operative procedures employed at the front in relation to subsequent infection of the joints, the most compelling facts are the importance of early operations in all high explosive wounds with thorough débridement of the wounds and revision of the joints, followed by capsule closure leaving the soft parts open.

The relation of the type of injury to the joint to subsequent infection and function of the joint will now be considered. Thirty-six patients had fractures of one or more of the articular surfaces of the knee. Twelve others had foreign bodies in the joint without gross injury to the articular surfaces, and in the remaining cases the joint was opened or penetrated without foreign bodies remaining in the joint or fracture of the articular surface.

The articular surface of the tibia was fractured alone in six cases. Four became infected following operation, and three of these were amputated following drainage of the joint that ineffectively controlled the sepsis. It is notable that of five amputations performed in this whole group of cases three were necessary in fracture of the tibia into the joint. The operative procedure employed in these cases at the front consisted in débridement of the wound over an oblique fracture of the shaft into the joint without opening the joint in four cases. Two of these became infected and required amputation. The two remaining uninfected had five degrees and fifteen degrees of active motion, respectively, seventy-five days after injury. Comminuted fracture of the head of the tibia was present in two cases and both became infected after opening the joint and removing loose bone fragments. One required amputation and the other had only five degrees of active motion after three months.

There were five patellar fractures from gunshot wounds. Two patellas were removed at the primary operation, both joints became infected, with ankylosis in one and amputation of the leg of the other for a Welch bacillus infection. In the three remaining cases the capsule of the joint was closed in one and the wound over the patella into the joint débrided and left open in two. These remained clean, and after three months from date of injury had a range of motion of fifteen degrees, twenty degrees, and normal, respectively.

Fracture of one or both condyles of the femur was the most frequent bone injury, occurring in sixteen patients. All were operated at the front. The capsule or capsule and skin were closed after débridement and revision of the joint in ten cases, sixty per cent. remaining clean. The joint was left open after primary operation in six cases, fifty per cent. remaining clean. Of the infected cases one required amputation and the others had only five to fifteen degrees of active motion three months after injury. Of the nine cases, seven, or seventy-nine per cent., had ninety degrees active motion, or better, and two had fifteen to twenty degrees of motion three months after injury. This marked variance in function of the knee-joint in the same type of injury emphasizes once more the deleterious effect of infection. It is also evident that fragments of the articular surface of the femur, in some instances amounting to nearly a whole condyle, may be removed without serious loss of function of the joint, provided that the joint remains clean.

Two or more bones entering into the articular surface of the knee were fractured in seven cases. After débridement and revision of the joint the capsule was closed in four, three of which remained clean. The joint was left open after operation in three patients and only one remained clean. The function in the infected joints was poor, ankylosis, or, at best, five degrees of active motion, being present, whereas in the uninfected joints two had ninety degrees or more and the others had

fifteen to twenty-five degrees of active motion three months after injury.

Twelve cases having no bone lesions had foreign bodies removed from the joint at the front, nine having a primary capsule closure and three being left open. Two-thirds of each group remained uninfected. The function of these joints differed in no way from those already tabulated.

The after-treatment of injuries, and especially infections of joints in relation to functions, has received marked attention since Willems, advocacy of Lucas Championniere and Rochard's principle of active mobilization of such joints. After thorough drainage, usually by lateral incisions and immediate mobilization of the joint by the patient's efforts, Willems contends that better drainage and much better function of the joint is obtained than by other methods of treatment. In 1918 he reported twenty cases of infections of joints of which thirteen eventually had practically normal motion. This treatment is in absolute contrast with the usual teachings regarding infected joints where immobilization for a long period has been the rule. Willems insists on mobilization immediately after operation.

The beneficial results of early active motion in non-infected joints is well supported by the experimental work of Phemister and Miller who removed the cartilage from the knee-joints of dogs with subsequent active mobilization of the joint. A new functional joint was formed in most instances and the articular surfaces of the bones were covered with new cartilage.

In the American scheme of medical organization, patients operated at the front during an offensive were evacuated to a base hospital as soon as possible, which was usually not later than two or three days after the operation. Knee-joints recently operated or injured were always immobilized as well as possible for transport. On arrival at the base hospital, the joints were not, as a rule, immediately mobilized, as they were very painful and the patient was tired and unwilling to actively move the joint. Injured knee-joints bore transportation poorly. Therefore, several days without active mobilization would pass and possibly at the end of that time another evacuation of the patient further to the rear was necessary. So in many cases arriving at the base, the joint had been immobilized by reason of necessity or circumstance for from one to two weeks. There were patients in whom active motion of the injured or infected joint was impossible or contra-indicated. Oblique fractures of the shaft of the femur or tibia into the knee-joint, extensive injuries of the soft parts in the region of the joint, long immobilization of injured joints with resultant restriction of motion and periarticular inflammation were generally contra-indications to the employment of active motion. Failure to obtain the patient's coöperation to actively move the joint occasionally occurred. It is also a question of judgment as to whether immediate active mobilization of a recently drained streptococcus in-

fected joint is advisable when the patient is septic. Personally, I do not believe it is and feel safer to wait forty-eight hours until the patient's temperature has fallen and his general toxic condition improved.

With these limitations we employed early active mobilization of injured or infected joints. At the beginning the patient was able to move the joint through about twenty degrees. Of the thirty-one uninfected joints, twelve had normal motion and sixteen others had over fifteen degrees of motion three months after injury, with progressive improvement in the latter group. It was necessary to drain thirteen knee-joints following gunshot injury at our hospital. We used long lateral incisions from the lower border of the patella to the upper limit of the subcrureal bursa, opening the bursa in its entirety. No drainage material of any kind was put into the joint. We were able to begin immediate active mobilization in only five cases. At the end of an average of forty-five days two had practically normal motion and all had twenty degrees or more motion in the joint. The other joints were immobilized because of previous long standing immobilization, fracture of the shaft of the tibia or femur, extensive wounds of the soft parts near the joint or periarticular inflammation and induration. The range of motion in these cases after an average of three months from the date of injury was under ten degrees. Though the function of these immobilized infected joints is poor, the well being of the patients was greatly improved after immobilization in several instances where misdirected efforts to obtain motion in the joints had resulted in a precarious general condition of the patient.

SUMMARY

1. Of the gunshot wounds of the knee coming to a base hospital after operation at the front, fifty-six per cent. remained uninfected and forty-four per cent. infected.

2. Of the infected cases, five required amputations, with one ensuing fatality.

3. Infection of the joint plays the most important rôle in decreasing the function of the joint.

4. Early operation at the front, thorough débridement of the wound, removal of foreign bodies and loose bone fragments from the joint, and closure of the capsule of the point are the most important elements in preventing infection of the joint.

5. Almost fifty per cent. of joints having fractures of the articular surfaces became infected after operation, whereas only thirty-three per cent. of other types of injury to the joint became infected.

6. Of the high explosive fractures of the condyles of the femur nearly sixty per cent. were uninfected after operation. Fractures of the tibia did not do so well.

7. Joints remaining uninfected after operation for fracture of the

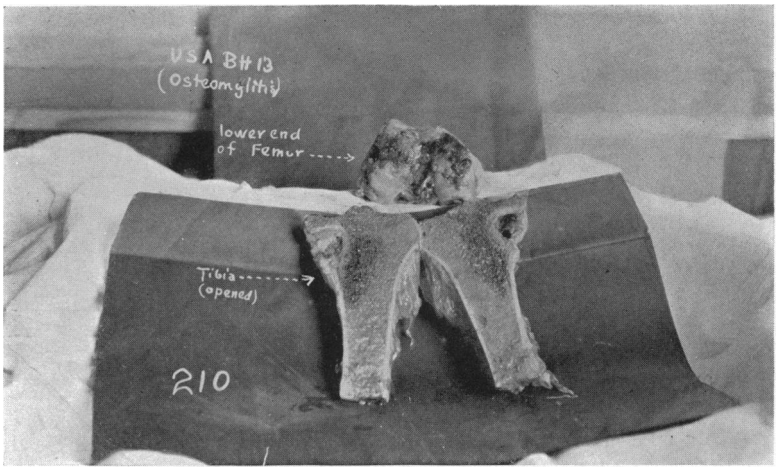

FIG. 1.—Patient wounded October 9, 1918, over upper end of tibia by high explosive. On October 27th definite infection of the knee-joint. Knee was drained by lateral incisions. Because of continued sepsis amputation was done on November 29th. Specimen shows osteomyelitic cavity at upper end of tibia and destruction of articular cartilage of the condyles of the femur from infection.

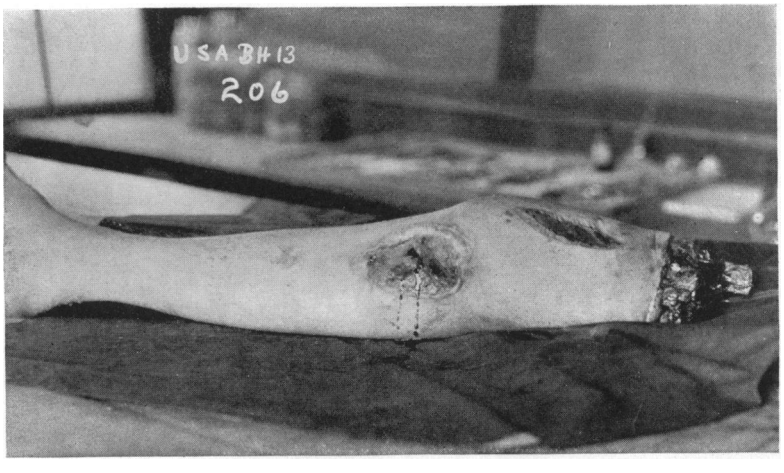

FIG. 2.—Same patient, showing leg with lateral incisions into subcrural bursa and below the wound over the osteomyelitis of the tibia.

articular surfaces had normal motion, or ninety per cent. active motion in seventy per cent. of the cases.

8. Whenever possible, injured or infected joints were actively mobilized after operation, but active mobilization is not practicable in all war injuries of joints.

9. Of the infected joints, all that were by necessity immobilized had only ten degrees or less active motion two months after injury. Of those actively mobilized immediately after drainage of the joint, two had normal motion and the remainder better than twenty degrees of active motion two months after their injury.